(7.)

A SYNOPSIS OF THE GEOLOGY OF DURHAM AND PART OF NORTHUMBERLAND.

BY

RICHARD HOWSE AND J. W. KIRKBY.

PUBLISHED BY THE
TYNESIDE NATURALISTS' FIELD CLUB.
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This Synopsis has been drawn up at the request of the Committee of the

TYNESIDE NATURALISTS' FIELD CLUB,

chiefly for the use of the Members of the

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,

attending the meeting of 1863. It is intended to answer as a sort of guide to such of the visitors as may wish to examine the geology of the district lying within easy reach of Newcastle. With this as their object, the authors have endeavoured to make it as much as possible a record of fact rather than an exposition of opinion. And they would observe also, that although they have striven to render it as perfect as the scope allowed them would permit, they are nevertheless well aware that they leave much untold, and much for the intelligent geologist to discover and observe for himself.

GEOLOGY OF DURHAM AND PART OF NORTHUMBERLAND.

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RECENT.

The deposits now in process of formation in this neighbourhood worth observing, consist of calcareous conglomerates, formed by the percolation of water charged with lime running over the rubbly gravel of elevated portions of the sea-beach. A deposit of this nature, containing artificial remains, may be seen in Frenchman's Bay on the coast of Durham. Accumulations of blown sand forming extensive dunes of considerable interest, from the mode in which they are stratified, are common along the coast from the mouth of the Tees to the Tweed. Estuarine silts, containing remains of land and freshwater animals and plants, intermixed with estuarine shells, are being slowly accumulated near the mouths of the Tees and the Tyne. The deposits of the Heathery Burn Cave appear also to belong to this period, containing the remains of human art and industry, associated with bones of still existing species of mammals.*

PRÆ-HISTORIC.

At two points on the coast of Durham there occur peat beds, or as they are commonly called, "submarine forests." The most northerly of these lies between tide-marks, near Whitburn, or about a mile and half to the north of Sunderland. When exposed, which only happens at very long intervals, the peat is seen to be about two feet thick, and to have below it a bed of unctuous blue clay. In the peat occur the remains of hazels and hazel nuts in great abundance, many of the latter having been gnawed by *Rodentia.* The only animal remains known to have been found in it are some antlers of Red Deer. This deposit, however, has been but imperfectly examined.

At West Hartlepool and along the coast nearly to Seaton Carew, there is often exposed between tide-marks a deposit of peat of much greater extent than the one just mentioned. Beneath the deposit have been obtained a tusk of the Mammoth, the antlers of Red Deer and of the Irish Elk, and the horn cores of *Bos longifrons.* These mammalian remains are often found wholly or partially washed out of the peat after storms, and specimens of them are preserved in the collections of Mr. Backhouse (Sunderland), Mr. Davison (Hartlepool), and the Hartlepool Museum.

A thin bed of peat has also been noticed at South Shields, below about twelve feet of brick earth. At the bottom of this bed, and resting on a stratum of marly clay, there were found in 1855 portions of a skeleton of the Irish Elk, which is now in the possession of the Natural History Society of Newcastle. From the same peat bed were also obtained the stems of the common ling *(Calluna vulgaris)* in great abundance.

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* See *Geologist,* vol. v.

Various other deposits in this district have yielded mammalian remains. At Chirdon Burn an antler of the Moose *(Cervus Alces)* has occurred in peat, and at Nab Hill near Mainsforth, antlers of the Irish Elk (*Megaceros Hibernicus*) have been met with in clay under a peaty soil. And at Jarrow Slake numerous bones and antlers of Red Deer, the horn-cores of *Bos primigenius*, with remains of forest trees and land and estuarine shells, have been found at various depths in silt.

Little has been done as yet towards a thorough investigation of the above deposits, and of course, still less towards determining their sequence, correlation, or even their exact geological positions.

POST GLACIAL.

Scattered over most of the eastern portion of Durham, and often resting on the Boulder Clay, occur deposits of clay, sand, gravel, and water-worn stones.* These deposits are sometimes comparatively superficial, but frequently attain a considerable thickness. In the neighbourhood of Sunderland they are met with from 30 to 150 feet above sea level. Further west they appear to reach a much higher altitude. They are generally stratified, and often false-bedded like beach and river accumulations. In the vicinity of the Magnesian Limestone the gravel is principally composed of fragments of that rock, with other fragments of mountain limestone, porphyry, basalt, &c., &c., that have been derived

* Erratic blocks of Shap Fell granite are associated with and washed out of these deposits along the Tees valley.

apparently from the Boulder Clay. In some localities these beds become consolidated by the infiltration of water charged with carbonate of lime (Hawthorne Hive). In some instances they contain remains of recent land shells.

It is difficult to speak precisely as to the geological age of these sands and gravels, further than to say that they are of subsequent date to the Boulder Clay. But whether they ought to be referred to the close of the Glacial period, when the North of England area was being re-elevated, or whether to a more recent period, is an undecided question. So far as our opinions are concerned we incline to the former supposition, and are disposed to look upon these deposits as the result of the wear and tear to which this area was subjected during the elevation referred to.

POST PLIOCENE—BOULDER CLAY.

The Boulder Clay is very generally distributed in Durham and Northumberland, covering the palæozoic rocks of these counties to a considerable thickness. When characteristically developed it consists of a brown or grey unstratified clay, often somewhat arenaceous, and largely charged with erratics. The latter belong to the various rocks which outcrop or are exposed to the west and north-west,—such as the shale, sandstone, and coal of the Coal Measures and Millstone Grit, Mountain Limestone, basalt, porphyry, and rarely granite, those of the latter rock being brought from Cumberland and Scottish localities. Associated with these is always a large percentage of fragments from the formation on which the clay immediately rests. Some of the boulders are angular, some sub-angular, but the majority are more or less rounded, grooved, and striated. The underlying rock is also sometimes scored and polished, the direction of the scoring varying according to the slope of the surface. Instances occur at the Trow Rocks * near South Shields, and at Ryhope Snook on the coast to the south of Sunderland. We know of no

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* The northern limit of the Mag. Lime., about 1½ mile south of South Shields.

localities in these counties where the Boulder Clay is fossiliferous.

In a few of the sections near the mouth of the Tyne a bed of compact bluish clay which is seen on the north side of the Tyne to rest on the Boulder Clay and pass into it, but on the south side rests on the limestone rock, is characterized by the presence of numerous fragments of flints with sharp angular edges not in the least water-worn. These are sparingly scattered through the bed, accompanied with small pebbles of pure white quartz, fragments of porphyry and sandstone—some of the latter are slightly rounded as if by glacial action. It is at present uncertain whether this bed is a reconstruction of the Boulder Clay or a prolongation on to this coast of the Scandinavian Drift. The flints seem to bear a very striking resemblance to some collected in the latter formation near Hamburg.

Localities.—One of the finest sections near Newcastle is at the mouth of the Tyne, on the north bank of the river, to the east of the Low Lights.* It is also very finely exposed on the coast at Hendon and the Blue House to the south of Sunderland.† It may be found in other places almost wherever it is looked for.

At the base of the Boulder Clay, between the Low Lights and Spanish Battery (Tynemouth) there occurs a coarse gravel or shingle that would appear to belong to an earlier period than that deposit. It is composed of fragments of magnesian limestone, porphyry, coal-measure sandstone, quartz, basalt, and granite; examples of the latter rock being more common than in the Boulder Clay. We have only seen it in this locality, and even there have not been able to examine it thoroughly. It is therefore chiefly mentioned to draw attention to the fact of its existence, as being the only deposit in the district that may possibly belong to a period older than the Boulder Clay.

* About ten minutes walk from the Tynemouth station.

† Twenty minutes walk from Sunderland.

NEW RED SANDSTONE.—TRIAS.

Some beds of reddish sandstone occur on the coast near Seaton Carew, and also on the Tees, between Stockton and Darlington, which are, perhaps, referable to this group. Very little is known of their true relations, but as they pass under the lias of the Cleveland district, and succeed the upper beds of the following formation, it is necessary, perhaps, to refer them to the Triassic period, the sandstones of which they much resemble.

PALÆOZOIC ROCKS.

These rocks form the mass of the strata of the counties of Durham and Northumberland, and perhaps in no part of the world do they form such a regular and connected series; so that the geologist, by following the coast section from Berwickshire to the Tees, has presented to him in gradual succession, the whole series of strata from the Silurian and Old Red Sandstone to the Upper Permian. By traversing the county from the coast of Durham to the plains of Cumberland, he will be able to examine the different members of the same series in a more inclined and regular position. Though this series of rocks has been locally disturbed, yet there appears to have been no great break between the Devonian and Carboniferous, nor between the Carboniferous and Permian periods, as is generally stated of the latter. The passage of the Carboniferous into the Permian has indeed been so gradual that it is often difficult to produce proofs of denudation and unconformability between them. This undisturbed order of succession in the Upper Palæozoic rocks is perhaps the most important point in our local geology, and most worthy the attention of geologists from a distance.

PERMIAN.

Divisions.	Localities.
1. Upper limestone.	Roker, near Sunderland; and Hartlepool.

Division.	Localities.
2. Middle limestone	Humbleton, Tunstall, South Shields, Ryhope.
3. Lower limestone.	Whitley, South Shields, and all parts of the escarpment.
4. Marl slate.	Tynemouth, Cullercoats, Claxheugh, &c.
5. Lower new red.	Tynemouth, Cullercoats, Westoe, Claxheugh, &c.

Under this term we include the Magnesian limestone, Marl slate, and Lower Red Sandstone,—the latter with some degree of doubt.

A glance at any geological map of Europe will show that these rocks, as distributed in Durham, lie in a somewhat triangular area of which the apex is South Shields, and the basal points Hartlepool and Pierce Bridge. From South Shields to Pierce Bridge they, as a rule, terminate in a well-marked outcrop or escarpment; from Pierce Bridge to Hartlepool they are bounded by the Trias; their junction with that formation is, however, invariably masked with drift and rubbly sand. The general dip of the Magnesian limestone and Marl slate is to the S.E. and E.S.E. And the Lower Red Sandstone appears to dip in the same direction. To obtain, therefore, a good idea of these rocks in their order of succession, it is necessary to traverse them across their outcrop in a westerly or north-westerly direction, or *vice versa.* Perhaps one of the shortest and best traverses of the kind is that (first noticed by Prof. King) running from Roker on the coast near Monkwearmouth, to Down Hill near West Boldon. At Roker we see, in the sea cliffs, a series of thin-bedded, compact, and occasionally oolitic, yellow limestones. By proceeding west to Fulwell Hill, and then along the ridge to Down Hill, these beds are seen to be successively underlaid; first, by a group of thick-bedded, crystalline, and concretionary limestone (Fulwell Quarries);

second, by a light yellow or greyish, and occasionally fossiliferous limestone of irregular structure (Red House, Southwick, Hylton Castle, East Boldon, Down Hill); third, by a more regularly stratified, compact limestone (Down Hill); fourth, by a thin deposit of finely laminated brown and grey marl slate (Down Hill); fifth, by a mass of incoherent, yellow, and false-bedded sandstone (Down Hill); below which appear to come the Coal Measures.

The same sequence of beds may be seen by taking other routes,—as from Halfway House Quarries, by Tunstall Hill, Humbleton Hill, Stoney Gate, to Newbottle. And, so far as relates to the limestone members of the series, in the coast section from Roker to the Trow Rocks, near South Shields. But it is difficult to observe whether this succession obtains in its integrity in the south of the county, so much of the surface being thickly covered with drift, the lower divisions thickening and predominating, the dislocation and displacement of the upper bed by violent faults running in adverse directions, and the want of natural cross sections.

In classifying the various members of the first-mentioned traverse, the Roker and Fulwell limestones are grouped as one subdivision under the name of *Upper Limestone.* The limestone of Southwick Red House, East Boldon, &c., as the *Middle Limestone.* The inferior limestone of Down Hill follows as *Lower Limestone.* The laminated marl slates and the incoherent sand are classed as the fourth and fifth members of the series under the denominations of *Marl slate* and *Lower Red Sandstone,* the latter including some beds of red sandstone which are not displayed at Down Hill. Thus, according to this system of classification, the Permian series of Durham is composed of five subdivisions, each of which is sufficiently well characterized to be distinguishable when seen alone.

The principal characters of each member we shall endeavour to point out in the following brief, systematic description.

For further particulars we must refer to Professor Sedgwick's admirable memoir "On the Geological Relations and Internal Structure of the Magnesian Limestone," to Professor King's "Monograph of Permian Fossils," and to papers by the Authors in the "Transactions of the Tyneside Naturalists' Field Club" and of the Geological Society.

UPPER LIMESTONE.—Upper portion yellow, compact, vesicular, oolitic, and thin-bedded. Some of the beds with casts of the following species—*Axinus dubius, Myalina Hausmanni, Clidophorus costatus, Turbo helicinus.*

Localities.—It is well exposed in Roker Cliffs,* and is also seen in a road-cutting near Monkwearmouth Cemetery, and at Hartlepool.

Lower portion yellow, whitish, or grey in colour; friable, earthy, compact, or crystalline in texture; often concretionary, usually thick-bedded, but sometimes flaggy and laminated. The characteristic feature of this portion of the Upper Limestone is its peculiar concretionary structures, the limestone of several of the beds assuming nearly every variety of form, some of which are of great beauty. Thus we have coralloidal, botryoidal, conglobated, spherical, mammillated, columnar, furcated, starlike and radiating limestones, besides other forms not easy to describe. On the whole, it is questionable whether there exists any other sedimentary rock whose original structure has been so remarkably altered as these beds of the Magnesian limestone.

Aggregate thickness 250 feet.

Fossils.—The species mentioned as occurring in the higher beds of this member are also found on various horizons in the lower, where they are occasionally associated with *Leda speluncaria.* Besides these shells there likewise occur in one locality (Byers' Quarry)† several forms of Entomostraca and Foraminifera. And we sometimes meet with obscure vegetable remains apparently referable to *Algæ.* But the most interesting fossils of the Upper Limestone are some fish-remains that have recently been found at Fulwell. These fossils are unfortunately comparatively rare, but often very finely preserved. Among them appear to be four species of *Palæoniscus,* and one species of *Acrolepis.* And occurring with them (rarely) are vegetable fossils belonging to *Calamites* and *Caulerpa.*

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* Situate on the coast to the north of Monkwearmouth, and about fifteen minutes walk from the railway station.

† On the coast between Whitburn and Marsden, about four miles south of Shields, and the same distance north of Sunderland.

Localities.—In various quarries on Fulwell Hill,* and especially in those belonging to Sir Hedworth Williamson, the concretionary beds are well developed. The whole of the lower beds are also finely exposed on the coast between Whitburn † and Marsden, as well as in quarries on Cleadon Hill,‡ at Halfway House § (Ryhope), and to some extent at Building Hill.|| The coast section is the best for invertebrate fossils, and Fulwell Old Quarry almost the only one for the vertebrate remains.

MIDDLE LIMESTONE (Shell and Cellular Limestone).—Generally light yellow or whitish, but sometimes brown or greyish in colour; friable, compact, or crystalline in texture; often cellular, and (in the north of the county) very irregular in structure, its stratification being obscure. When fossiliferous it is the *Shell Limestone* of Sedgwick, and the *Fossiliferous Limestone* of King; when unfossiliferous it is the *Cellular Limestone* of Sedgwick (in Durham); and the *Pseudo-brecciated* of King. As shell-limestone it is the most highly fossiliferous member of the series, both in regard to number and diversity of species and abundance of individuals. The following list includes all the most common

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* Immediately to the west of the Newcastle road, about 1¼ mile north of Sunderland Bridge.

† ‡ These localities can be most easily reached from the Cleadon Lane station, on the Sunderland and Newcastle branch of N.E. Railway.

§ On the coast a little more than a mile to the south of Sunderland.

|| Mowbray Park, Sunderland.

and characteristic forms; besides these there are others of rarer occurrence, which brings up the list to 120 species.

Nautilus Freieslebeini. *Geinitz.*
Pleurotomaria antrina. *Sch.*
Turritella Altenburgensis. *Gei.*
Turbo helicinus. *Sch.*
Eulima symmetrica. *King.*
Gervillia keretophaga. *Sch.*
Lima Permiana. *King.*
Arca (Macrodon) striata. *Sch.*
Monotis speluncaria. *Sch.*
Myacites elegans. *King.*
Myalina Hausmanni. *Goldf.*
Pecten pusillus. *Sch.*
Athyris Royssii. *L. Eveillé* (pectinifera, *Sow*).
Camarophoria crumena, *Mar.* (Schlotheimi, *Von Buch*).
Cam. globulina. *Phillips.*
Cam. Humbletonensis. *Howse.*
Producta horrida. *Sow.*
———— latirostrata. *Howse.*
Spirifera alata. *Sch.*
———— Urii, Fleming (Clannyana. *King.*)
Axinis dubius. *Sch.*
Cardiomorpha Pallasi. *De Vern*
Clidophorus costatus. *Brown.*
Edmondia elongata. *Howse.*
Gervillia antiqua. *Mün.*
Spiriferina multiplicata. *Sow.*
———— cristata. *Sch.*
Streptorhynchus pelargonatus *Schloth.*
Strophalosia Goldfussi *Münst*
———— lamellosa. *Gein.*
Terebratula sacculus, *Martin.* (elongata & sufflata, *Sch.*)
Fenestella retiformis. *Sch.*
Ichthyorachis anceps. *Sch.*
Thamniscus dubius. *Sch.*
Synocladia virgulacea *Phillips*
Cythere (Bairdia) plebeia. *Reuss.*
Kirkbya Permiana. *Jones.*
Cyathocrinus ramosus. *Sch.*
Stenopora collumnaris. *Sch.*
Miliola (?) pusilla. *Gein.*

Localities.—As shell-limestone this member may be best studied at Humbleton[*] and Tunstall Hills;[†] it is also exposed at Claxheugh,[‡] Hylton Castle,[§] Ryhope Field

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[*] Rather more than a mile from Sunderland, on the road from that place to Durham.

[†] About half an hour's walk from Sunderland on the road to the hamlet of Tunstall.

[‡] On the south bank of the Wear, about two miles west of Sunderland.

[§] About three miles from Sunderland, on the North Hylton road.

House,[*] Dalton-le-Dale;[†] and its junction with the Lower Limestone may be seen at Humbleton and Claxheugh. Under its cellular aspect it is well developed at the Trow Rocks near South Shields, where it is being extensively quarried for the pier works now in progress at the mouth of the Tyne; it may also be seen at Down Hill, and on the banks of the Wear above the bridge, also on the coast from Halfway House to Castle Eden Dene, and in various other localities; its junction with the Lower Limestone is beautifully exposed in Frenchman's Bay,[‡] between Marsden and South Shields, and also at Down Hill.

LOWER LIMESTONE *(compact Limestone of Sedgwick and Auct).* — Brown, grey (sometimes ribboned with these tints), yellow, or whitish in colour; generally more or less compact, crystalline, or friable in texture; occasionally concretionary; almost invariably with well-marked stratification, though varying from thick-bedded to slaty. Generally unfossiliferous; and when the contrary the fossils are not numerous either in species or individuals, though sometimes very finely preserved. Altogether, thirty-eight species have been met with in this member, and the most comparatively common of those are—

Producta horrida, *Sow.*
Spirifera alata, *Sch.*
Camarophoria crumena, *Martin.*
Strophalosia lamellosa, *Gein.*
Gervilla antiqua, *Mün.*
Fenestella retiformis, *Sch.*
Miliola (?) pusilla, *Sch.*

The only species peculiar to it is *Astarte Vallisiariana*, King.

Localities.—Whitley,[§] Frenchman's Bay, Down Hill, Pallion,[*] Claxheugh, Hartley's Quarry (Bishopwearmouth),[†] Pensher,[‡] Newbottle, Houghton-le-Spring, Downs Quarry, Moorsley, Pittington, Sherburn, Running Waters, Ferry Hill, and numerous other places along the escarpment. It is fossiliferous at Whitley, Moorsley, East Thickley,[§] Summerhouse,[||] and Hartley's Quarry, but it is only by very close research that these localities can be made to yield any results to the palæontologist.

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[*] An old farm quarry, a little to the west of Ryhope, three miles south of Sunderland.

[†] An old quarry on the east side of the Sunderland and Stockton road, a little to the south of Dalton-le-Dale.

[‡] Nearly two miles south of South Shields.

[§] Two miles north of Tynemouth, at present partially drowned out as a locality.

MARL SLATE.—Yellow, brown, grey, or almost black in colour. Soft or unctuous, compact, moderately hard, rarely crystalline in texture, almost invariably laminated; and rarely exceeding three or four feet in thickness, though its maximum would appear to approach ten feet. Generally fossiliferous, but often very slightly so. The fossils chiefly belong to fishes; with occasional traces of plants, and rarely shells of the genera Lingula, Discina, and Myalina. The following species may be termed characteristic:—

Palæoniscus comptus, *Agassiz.*
——— elegans, *Sedgw.*
macropthalmus, *Ag.*
Platysomus striatus, *Ag.*
Pygopterus mandibularis, *Ag.*
Cælacanthus granulatus, *Au.*

Acrolepis Sedgwickii, *Ag.*
Caulerpa selaginoides, *Sch.*
Lingula mytiloides, *Sow.*
(Credneri, *Gein.*)
Discina nitida, *Phillips*
(Konincki, *Gein.*)

The fish-remains are occasionally very finely preserved, though this is perhaps the exception. The vegetable fossils are usually very imperfect. The shells, though pretty well preserved, have only been found in the south of the county.

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[*] On the south bank of the Wear, about a mile west of Sunderland.

[†] Just to the west of the Wear Glass Works; ten minutes walk from the Monkwearmouth Railway station.

[‡] This and the localities that follow, are all on the western escarpment, and they are in most cases of comparatively easy access from stations on the N.E. Railway.

[§] Near to the Shildon station of the Stockton and Hartlepool Railway; is now enclosed as a rabbit warren.

[||] Seven miles north-west of Darlington.

Localities.—Cullercoats* and Tynemouth (outliers to north of the Tyne and 90 fathom dyke), Claxheugh, Hartley's Quarry, Ferry Hill, Midderidge,† &c.

Lower Red Sandstone.—Upper bed yellow, incoherent, quartzose, strongly false-bedded, and of variable thickness. Lower portion red, more compact (though still comparatively soft), finer in texture, micaceous, and somewhat more regularly bedded; with local intercalations of nodules and of pockets of red and green shale.

Aggregate thickness, 100 feet.

In the upper incoherent bed no fossils ever occur, but in the lower bed the following species have been found at Tynemouth and South Shields :—

Gyracanthus granulosus, *Ag.*
Pinites Brandlingi, *Lindley.*
Trigonocarpon Nöggerathi, *Brong.*
Neuropteris gigantea, *Brong.*
Sphenopteris latifolia, *Brong.*
Sigillaria reniformis, *Brong.*
Lepidodendron sp.
Calamites approximatus, *Sch.*
———— inequalis (?) *Lind.*
Cyclopteris dilatata.

Localities.—The upper incoherent beds are well exposed at Claxheugh, Hylton Dene, Newbottle, Downs' Quarry, and at various points on the escarpment.

The lower red beds occur in sections at Tynemouth Cliff, in quarries at South Shields, and on the north bank of the Wear opposite to Claxheugh.

It has been already observed that we include the Lower Red Sandstone as Permian with some hesitation, for it will be seen that all its fossils are Coal Measure species. This fact would certainly have induced us to place it in the Carboniferous system, rather than with the Permian strata, had we not been aware that several other Carboniferous species extend up into the Magnesian Limestone. We therefore, with some reluctance ignore for the present the palæontological evidence, and classify this deposit as we do on the grounds of its apparent conformability with the Magnesian Limestone.—J. W. K.

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* Between tide-marks at the fishing village of the same name, two miles to the north of Tynemouth.

† A little to the east of the Shildon station, on the Stockton and Hartlepool Railway.

OUTLIERS.—South Shields has been mentioned as the northern limit of the Permian Rocks, so far as concerns their distribution *en masse.* Beyond this point however two outliers occur that seem worthy of mention. The first is at Tynemouth, where a small patch of the Lower Red Sandstone, Marl slate, and Lower and Middle Limestones occurs in section in the cliffs immediately under the lighthouse. The second is at Whitley, where a comparatively large area of the Lower Limestone has been thrown down by the 90 fathom dyke, and is extensively quarried for lime-burning. This outlier is immediately to the north of the 90 fathom dyke. And what is evidently a continuation of it is seen on the coast at Cullercoats, the Lower Red Sandstone, Marl slate, and one or two beds of Lower Limestone occurring there in exactly the same position in regard to the dyke.

FAULTS AND DYKES.—Next to the 90 fathom dyke, whose connection with the strata under description is noticed in the preceding paragraph, the most notable dislocation of the Permian rocks in this district is to be seen on the banks of the Wear at Claxheugh. At this locality an upcast fault to the east crosses the bed of the river in a north-westerly direction, bringing up the Coal Measures to a level with the upper portion of the Lower Red Sandstone. The effects of this fault are again visible at Millfield near Bishopwearmouth, about a mile and a half to the north-east. Several other faults appear to cut through the Magnesian Limestone on the coast near Black Halls, where the Upper Limestone is let down to a position parallel to the Middle Limestone. These are the only dislocations of any importance affecting the Permian rocks of which we have cognizance, though we are far from saying that they are the only ones that occur.

But besides the faults above mentioned, there are of course numerous minor breaks affecting the limestone, some of which possess considerable geological interest. Sometimes these latter take the form of rubble or brecchia dykes, the space between the walls of the fissure being filled irregularly with large and small angular blocks of limestone, cemented together with a calcareous paste. Remarkable examples of these occur on the coast between the Tyne and the Wear, one of the best being the "Chimney" just to the south of Marsden grotto. The remarkable appearances presented by these brecchias at Marsden may, we think, be explained by the filling up of large fissures and chasms with broken fragments of the superincumbent strata, and may perhaps be safely attributed to earthquake action on these rocks at an early period.

No example has yet been seen in Durham of dykes of igneous rock passing through the Permian strata. Various basaltic dykes are met with in the Durham Coal Measures underlying the Magnesian Limestone, but they have never been seen to pass up into the Magnesian Limestone. At Tynemouth the Lower Red Sandstone of the outliers previously mentioned is traversed by a dyke of basalt *(melaphyr)*; but where the dyke traverses the outlier the Magnesian Limestone is unfortunately denuded, or we might perhaps have seen it passing higher up into the series than we can observe at present.

COLLECTIONS OF PERMIAN FOSSILS.—It may be of some service to the palæontologist to mention the local collections of Permian fossils.

Perhaps the best series of fishes from the Marl slate belongs to the Natural History Society of Newcastle, and is exhibited in their Museum. In the same institution is also a good series of Permian invertebrata.

There are some examples of Marl slate fishes in the Sunderland Museum (Fawcett Street); and also the well-known fossil fish of Pallion *(Platysomus striatus)* from the Lower Limestone.

The collection of Mr. R. Howse (35, Saville Street, South Shields,) chiefly represents the invertebrata of the limestone and vegetable fossils from the Lower Red Sandstone.

Mr. Kirkby's collection (5, High Street West, Sunderland,) is also principally of invertebrata, but likewise includes fish-remains from the Upper Limestone.

Mr. E. Wood, of Richmond, has also a very fine collection of fishes from the Marl Slate of Midderidge.

CARBONIFEROUS.

The Carboniferous rocks of Durham and Northumberland may be grouped under the following heads, viz.:—

1. Coal Measures, Auct.
2. Millstone Grit, Auct.
3. Yoredale Rocks, Phillips.
4. Scar Limestone Series, Phillips.
5. Tuedian Beds, Tate.

1. Coal Measures.—This properly includes all the strata from the base of the marl slate to the lowest seam of workable coal, called in this district the Brockwell. It consists of numerous beds of fine or coarse-grained sandstone (post) of variable thickness, interstratified with beds of arenaceous or pure shale (metal). Among these and most thickly developed in the lower part of the series, though by no means confined to that portion, are the valuable workable seams of coal. These seams of coal vary greatly in thickness and quality, and as they split or are divided occasionally

into two seams, and receive different names in different districts, their identification is difficult, and has not hitherto, we believe, been perfectly accomplished. This desirable result could however be successfully attained by running close traverses across the coal-field from east to west, the numerous collieries working in the district and the registered sections of many others affording excellent and reliable material for such a purpose. Reference may be advantageously made to the late Mr. Buddle's excellent "Synopsis of the Newcastle District," in which the seams of coal worked on the Tyne and Wear are correlated in a masterly manner.*

Aggregate thickness, 2,000 feet.

Fossils.—These consist chiefly of plants, of which the most important belong to the genera *Calamites*, *Sphenopteris*, *Alethopteris*, *Neuropteris*, *Cyclopteris*, *Lepidodendron*, *Lepidophyllum*, *Sigillaria* &c., &c., the species of which are too numerous to mention, but most of which may be seen in the local collections of the Newcastle Museum. Besides these are more rarely found interesting remains of the sauroidal fishes, *Megalichthys* and *Holoptychius* which are so characteristic of this group of strata. A few Unionidæ and other freshwater shells, and two or three Entomostraca, and traces of other crustaceans have also been observed. The small freshwater *Microconchus carbonarius* is characteristic of these beds from the lowest to the highest member.

In addition to the above, one indication has occurred of marine conditions — a small dwarfed variety of *Lingula mytiloides* having been detected in a bed of fine shale and at considerable depth in the series.

Extent.— The boundaries of the Northumberland and Durham coal-field are indicated on the west by an undulating line running from the mouth of the Coquet to Ovingham on the Tyne, and thence by Witton on the Wear to the Cockfield dyke, south of which very few workings occur. It passes under the magnesian limestone in the east of Durham, and is bounded by the line of the sea-coast. Through the influence of the 90-fathom dyke a small strip of the Coal Measures runs parallel with the Tyne valley to nearly the edge of the Pennine fault. Along this line are the Stublick, Conewood, and Hartley Burn coal-fields.

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* Nat. Hist. Soc. Trans. vol. i. p. 215.

The effect of this dyke in prolonging the Coal Measures across the county nearly to the Pennine fault, was we believe first pointed out by Nicholas Wood, Esq., in the Nat. Hist. Soc. Trans., vol. i. p. 302, Section of the Coal Measures in the deepest part of the basin, on the Wear near Monkwearmouth.

2. MILLSTONE GRIT.—We include in this division the series of grits, sandstones, and subordinate shales between the Brockwell coal seam and the uppermost bed of carboniferous limestone which is locally termed the Fell Top limestone, from its usual position near the top of the fell. It is chiefly composed of sandstones and grits, some of which are very coarse, enclosing large angular pieces of quartz. The beds of this division are of variable thickness, being more strongly represented in some districts than in others.

Fossils.—Fragments of plants of species allied to or identical with those of the preceding division. A few of the beds in the lower portion containing remains of *Orthis*, *Spirifera*, and other brachiopods, appear to be of marine origin.

Extent.—This division crops out conformably beneath the Coal Measures to the west, and forms a narrow belt running across the two counties from the sea-coast between the mouths of the Coquet and Aln to Stocksfield and Riding Mill on the Tyne; thence it follows the outcrop of the Coal Measures to the Wear and Tees. It also caps the higher portions of the fells further to the west, and forms the summit of the highest elevation of the Pennine range—Cross Fell. In all the geological maps hitherto published, too great an area has been assigned to this division of the Carboniferous rocks. The following section will give a tolerably accurate idea of the nature of this series as it occurs on the Derwent :—

	Fms.	ft.
Slate sill	2	3
Plate	3	3
Girdle beds ...	2	0
Plate	2	3
Sandstone, fine-grained	7	0
Hazle, coarse ...	1	3
Plate and Blue whin	1	0
Plate and Grey beds	0	2
Sandstone and whin	1	2
Plate and whin ...	1	5
Plate	2	3
Millstone grit ..	5	0
Plate	4	3
Hazle	2	3
Grey beds (layers of slate clay & sandstone alternating)	1	0
Sandstone	7	0
Plate	1	0
Hazle and slate ..	2	3
Plate or Famp	2	0
Hazle and plate ...	2	3
Plate	2	0
Hazle or slate ...	1	3
Plate and Grey beds	1	3
Grey beds	15	0
Low grit ...	5	0
Pebbles	0	0
Plate	2	5
	82	0

3. YOREDALE ROCKS.—In this series we include all the strata from the Fell-top limestone inclusive to the Great Whin Sill. It is composed, as the appended section will show, of an assemblage of blue-coloured beds of carboniferous or encrinital limestone separated by extensive layers of indurated sandstone (HAZLE), bituminous shale (PLATE), thin seams occasionally of impure coal with accompanying thin underclays and tufts. In the Alstone Moor and Weardale districts, where this series is typically or most highly developed, there are nine distinctly defined beds of encrinital limestone, varying from two or three to sixty feet in thickness (Great limestone.) These are very uniformly distributed over the above districts, and also in the adjoining valleys of the Tees, South Tyne, West Allen, and Derwent, where they occupy, with variations in thickness, the same relative

position in the series. In the east and west veins traversing these limestone beds are deposited the strings and flats of galena which constitute their chief mineral importance. The sandstones of this division denominated hazles have a highly crystalline and metamorphic appearance. The majority of these beds are of marine origin.

Fossils.—In some of the sandstones and shales the usual plants of the carboniferous rocks are discovered ; but others are characterized by marine shells and corals. The limestones without exception contain marine shells and corals, and for the most part are formed of minute portions of the decomposed stems of the encrinite. The species most conspicuous are the large cockle of theminers, *Producta gigantea*, which is universally distributed, *Orthis resupinata*, *Spirifera* and a few other brachiopods, *Orthoceras*, *Encrinites*, and a few Corals; *Turbinolia*, *Lithostrotion*. Trilobites have very rarely been detected. The partings of the shaly sandstones are covered with the burrowings of some, as yet, unknown crustaceans. The fossils of the southern portion of this district have not yet been assiduously collected, but in part of Northumberland Mr. George Tate, of Alnwick, has carefully collected and preserved the fossils of this division.

Extent.—It covers the whole of the western portion of the county of Durham, from the outcrop of the lowest members of the Millstone grit series, and the adjoining portions of Westmoreland, Cumberland, and Northumberland, to the Pennine ridge, down the Western slope of which it extends to the Great Whin Sill. It stretches, bounded by the Whin Sill on the west, through the county of Northumberland, occupying the line of the sea coast, from the mouth of the Aln to the Tweed. The upper parts of the valleys of the Tees, the South Tyne, Wear and Derwent ; the valleys of the east and west Allen ; the lower part of North Tyne, Wansbeck, Coquet, and Aln are cut out of this series. In the three former valleys the whole series may be observed from the Fell Top limestone to the Great Whin Sill.

The following section shows the order of succession of these beds on the Alston Moor district, and applies also to Weardale and Teesdale :—

	Fms.	ft.
LIMESTONE (*Fell Top*)	1	0
Crow Coal occasionally, Hazle, or Upper Coal sill	1	0
Plate (Shale) ...	8	0
Hazle (indurated sandstone) ...	1	4
Plate	2	3
Hazle	2	2
Plate	1	0
Upper Slate Sill	4	0
Plate	5	2
Whetstone sill (fine-grained sandstone)	1	3
Plate	2	0
Ironstone (with coal)	1	1
Freestone (with iron pyrites)	5	3
Plate	6	1
Girdle beds ...	0	5
Plate	3	3
Hazle (Pattison's sill)	1	3
Plate	3	0
LITTLE LIMESTONE	1	4
Little Hazle ...	0	5
Plate Coal ...	2	0
High coal sill ...	1	4
Plate Coal ...	1	0
Low coal sill ...	2	0
Plate	3	2
GREAT LIMESTONE	10	4

	Fms.	ft.
Tuft	1	2
Plate	2	1
Limestone post (calcareous sandstone)	0	4
Quarry Hazle ...	4	0
Plate	5	0
Great Girdle bed ...	1	0
LIMESTONE (*Four-fathoms*) ...	4	0
Quarry Hazle (*Nattrass Gill*) ...	4	0
Plate	6	0
LIMESTONE & LITTLE WHIN SILL (three yards Weardale)	2	0
Plate	2	0
Hazle (Arthur's Pit quarry sill, six fathom Hazle) ...	4	0
Plate	1	4
LIMESTONE (five yds. Weardale) ...	1	2
Hazle	2	0
Plate	1	3
LIMESTONE (*Scar*)	9	0
Plate	0	3
Grey beds (coal occasionally) ...	2	1
Plate	1	2
LIMESTONE (Cockle-shell, (*Producta Gigantea*) ...	0	1½

	Fm.	ft.
Hazle	2	3
Plate	0	4
LIMESTONE ...	0	4½
Plate	4	3
LIMESTONE (Tyne-bottom)... ...	3	4
Whetstone ...	0	4½
WHIN SILL (Igneous)		
	164	2½

4. SCAR LIMESTONE SERIES.—From the Great Whin Sill inclusive to the lowest bed of carboniferous limestone. It is composed like the former series, of several beds of encrinital limestone, some of which are locally of great thickness (Melmerby Scar limestone is sometimes 120 feet), interstratified with beds of crystalline sandstone and plate, and a bed or two of coal. Between the North Tyne and the Tweed, in the lower part of this series, the beds of coal become more frequent, thicker, and of better quality than in the Pennine escarpment, and the limestones thinner, impure, and deteriorated. In the middle of this series the Plashetts and Scremerston coal beds are situated.

Fossils.—Some of the land plants identical with species belonging to the above division, with others apparently distinct. Several of the marine fossils are also identical, but many of the following are not known in the higher part of the series in this district, viz.—*Myacites sulcata*, Flem. sp.; *Edmondia arcuata*, Phillips *sp.*; *Axinus axiniformis*, Phill. *sp.*; *A. carbonarius*, Sow.; *Nucula gibbosa*, Flem. *sp.*; *Leda attenuata*, Flem. *sp.*; *Producta gigantea*, Mart.; *P. Martini*, Sow.; *Chonetes* 2 *sp.*; *Strophomena analoga*, Phill. sp.; *Athyris ambigua*, Sow.; *Discina nitida*=*Konincki* of Permian group; *Conularia quadri-sulcata*, Sow.; *Loxonema rugifera*, Phil.; *Goniatities*; *Orthoceras*; *Cyathopsis* sp., &c. The marine fossils of this series are identical in many species with those of the Coalbrookdale coal field, and also with those of the coal formation of America, as may be seen by referring to the works of Prestwick, McChesney, and Hall.

Extent.—It crops out along the base of the Pennine range till the escarpment of the latter is thrown down by the Stublick or 90 fathom dyke. Thence it occupies the western part of Northumberland from the Whin Sill to the foot of the Cheviot range. Good sections may be seen in the burns and smaller valleys of the North Tyne and Coquet, and at the base of the Pennine escarpment as near Dufton in Westmoreland, where the following sections of this series may be observed :—

	Fms.	ft.
GREAT WHIN SILL	10	0
Plate	3	0
Hazle	2	0
Plate	2	0
Hazle	3	0
Plate	1	1
Limestone (Jew)	3	0
Plate	1	0
Hazle	5	0
Plate	1	1
Limestone (Little)	1	0
Hazle	1	1
Great hazle	10	0
Plate	4	0
Limestone (Smiddy)	4	1
Hazle	1	0
Limestone	4	1
Hazle	1	0
Limestone	3	0
Plate	1	1
Limestone	1	1
Plate	1	1
Great Limestone (Robinson's)	14	0
Hazle	1	1
Plate	0	1
Limestone (Melmerby Scar)	21	0
Plate	2	0
Sandstone	1	0
Plate and Coal (thin)	1	0
Limestone	4	0
Sandstone	18	0
Plate	1	1
Sandstone	1	1
Plate	2	0
Sandstone	1	1
Plate	1	0
Sandstone	1	1
Plate	1	0
Limestone	2	0
Hard sandstone	2	0
Plate and Coal (7 in.)	8	0
Sandstone	26	0
Girdle bed	2	0
Limestone	3	0
Sandstone	30	0
Plate	10	0
	228	2

TUEDIAN GROUP (Tate).—This name has been applied by Mr. George Tate to a large series of beds, lying beneath the carboniferous limestone of the last division, which are extensively developed on the banks of the Tweed. "It is composed of numerous beds of grey, greenish, and lilac shales, sandstones, slaty and calcareous sandstones, thin beds of argillaceous limestone and chert, and a few buff coloured magnesian limestones. It forms a well-marked transitional series, intercalated between the Scar limestone series and the Old Red Sandstone." On the banks of the Whiteadder gypsum may be seen among the sandstones of this series.

Fossils. — *Stigmaria ficoides*, *Lepidodendra*, Coniferous trees and other plants occur in some parts of the group. There are no workable beds of coal. The Fauna consists chiefly of fish-remains, Modiolæ and Entomostraca. In one bed on the Tweed, Orthocerata and Pleurotomariæ are associated with coniferous wood. The whole group is specially distinguished by the absence of Brachiopods, which are abundant in the overlying series. Generally freshwater and lacustrine conditions are indicated; and when marine remains do occur, they are accompanied with plants which appear to have been swept into the shallow estuary."

Extent.—" This group occupies a considerable area in the north of Berwickshire. There are good sections on the Tweed and Whiteadder. In Northumberland there are sections of it in Garmitage Bank and Crawley Dene, which are from six to nine miles west of Alnwick; and the same group is tilted up against the Cheviot porphyry in Biddleston Burn, and in the Coquet below Linn Brig."—*Tate.*

FAULTS.—The entire series of the carboniferous rocks are much more intersected and disturbed by faults than the preceding group. The most remarkable of these are the 90 fathom dyke and Butterknowle dyke intersecting the Coal Measures and affecting the Permian rocks also. These run from east to west across the coal field. The Burtree-ford dyke has a course nearly north and south, and is seen to affect the Yoredale rocks only.

The 90 fathom dyke or fault can be best seen on the coast near Cullercoats, where it brings in the Magnesian limestone, Marl slate, and uppermost coal strata. It appears to have at the surface an angle of 45° and the rocks on the north side dip at nearly the same angle. At the distance of a few hundred yards to the north they regain a more horizontal position. The strata on the north side of the fault are thrown down at this point about 45 fathoms, but the amount of throw is much increased along the line of dislocation further west. From the south side of Cullercoats bay it runs in a direction nearly west; it then takes a more southerly direction, and passing near Gosforth (a mile north of Newcastle) to Denton, it crosses the Tyne near Newburn, and running in the direction of Ryton, passes into another large fault known as the Stublick dyke. The latter, if we admit the Heworth dyke to be a continuation of it, crosses the country from the great Pennine fault on the west, to the eastern coast near Whitburn. This fault considerably affects the general strike and dip of all the strata to the north of it, and brings in considerable patches of the Coal Measure along its course as at Stublick, Midgeholm, Conewood, and Hartley burn. These important modifications of the outline of the northern coal fields, were first pointed out and mapped by Mr. Nicholas Wood, in the Transactions of Nat. Hist. Soc., vol. i., and though for long so well known in this district, all our geological maps till lately ignored this prolongation of the coal fields to the west. The effect of this dyke in disturbing the strata is perhaps best comprehended by considering that the Pennine chain, which a little further south attains an altitude of 2000 feet, is thrown down, and has on the line of the Carlisle Railway an altitude of only 450 feet. It is filled with basalt along the most western part of its course.

The Butterknowle dyke occurs in the south of the county of Durham. It throws the strata down to the south. On the sea-coast its effects can be seen by the sudden cutting off of the Magnesian limestone beds, and on the line of escarpment, by the prolongation of the Magnesian limestone five or six miles to the west.

The Burtree-ford dyke is a north-and-south fault of considerable magnitude crossing the lead-mine district from the vale of the Tyne to the Tees. Its effects are seen in the Allen and higher parts of the Wear and Tees. In the two former rivers the Great Whin Sill is brought to the surface, and in the latter the same bed is thrown down and consequently extends along the valley of the Tees for several miles.

IGNEOUS ROCKS.

The Igneous Rocks of the district consist of interstratified basalt or melaphyr, and dykes of the same mineral filling some of the old east-and-west fissures of the carboniferous rocks.

Great Whin Sill.—This enormous mass of interstratified basalt is seen to the greatest perfection in the higher part of the Tees, where it occupies the course of the stream for many miles, and forms perpendicular, massive cliffs on its banks. It outcrops all along the Pennine escarpment till the latter is thrown down by the Stublick dyke; it gradually rises out of this depresssion and outcrops to the north of the valley of the South Tyne, forming an elevated, conspicuous ridge. Along the summit of this ridge the Romans erected a portion of the wall which extends between the Tyne and Solway. The course of the Whin sill trends from Sewing Shiels Crags across the North Tyne in a north-easterly direction, forming huge, bastion-shaped masses along its course through the county of Northumberland. On the sea-coast at Dunstanborough it forms an enormous wall of rocks facing the sea. It occurs again on the sea-coast in the neighbourhood of Bamborough and the numerous small islands of the Farn and Staples. It passes from Bamborough in the direction of

Belford on the north road, forming conspicuous ridges as far as Kyloe Crags. On the South Tyne the Whin sill occurs at the highest part of the river, and it is brought by faults into most of the small burns that run into it from the west. In the Wear it is brought in at Burtree-ford by the fault mentioned above.

Little Whin Sill.—This small whin sill, which was so carefully described by Sir Walter Trevelyan in the Trans. of the Nat. Hist. Soc., is generally confounded with the former, but it occupies, as stated in the above reference, a higher position in the limestone series, and is much finer grained and more compact in structure than the above. It occurs only in the neighbourhood of Stanhope in Weardale, where it occupies the bed of the river for several hundred yards. It then rises to the west, and is seen in section occupying the same relative position in the strata, and gradually becoming thinner till it disappears altogether. It forms therefore a wedge-shaped mass towards the west. It is situated in a bed of limestone, composed of three posts or layers (three-yard limestone Weardale—five-yard limestone Alston Moor, see section above). It occurs uniformly between the upper and middle post or layer of this limestone bed, and is abruptly cut off towards the east.

Another intercalated mass of basalt occurs at Bolam, connected with the Cockfield dyke. The particulars of this may be seen in the Cambridge Transactions. Two opinions have been expressed in regard to the mode in which the Whin sill has become interstratified with the carboniferous rocks. One by Prof. Sedgwick in the Cambridge Transactions, that it was intruded or thrust in in a molten state after all the rocks of the series had been formed and consolidated; and the other, by Mr. Hutton, that it was poured over as lava on the superjacent strata before the upper beds were formed. The latter hypothesis is utterly untenable if we consider for a moment that there is no volcanic ash underlying any part of this bed or accompanying it, as there certainly would have been had it been poured over the surface from some volcanic vent; and also the basalt is extremely homogeneous and compact, and not vesicular in any part. Much detail concerning this bed may be found in the Cambridge Transactions, in the Nat. Hist. Soc. Trans., and in Prof. Phillips' Geology of Yorkshire, vol. ii.

The basaltic (melaphyr) dykes traversing the carboniferous series of rocks are too numerous and too imperfectly known to be referred to in this Synopsis. In general they have a course from west to east; they have been intruded at different periods, and vary considerably in width and mineral composition. The Wallbottle Dene dyke may be seen in the small dene of that name to the west of Newcastle. Passing through the adjacent colliery, and under Newcastle, it crosses the Tyne between Walker colliery and Hebburn, passes under Hebburn Hall, and in former years was worked for road metal at Brockley Whins station. Lately it has been reached in the workings of Hartley colliery. The Coalyhill whin dyke lies to the north of the former. It is worked for road metal at Coalyhill. A bed of coal was formerly seen here in contact with the south side of the dyke. The coal is completely coked and formed into prisms, specimens of which may be seen in the Newcastle Museum. The course of this dyke eastward has not been carefully traced, but it does not as supposed jump into the Wallbottle dyke, as it is distinctly seen in the cliff at Tynemouth, and can be identified by its mineral composition. At Tynemouth it has been partially bared, and the south cheek of it is visible near the western extremity of the pier. At this place it is distinctly divided into two masses, which are separated by large masses of impure calcedony and rough quartz crystals. A small portion of it still stands in the cliff close to the commencement of the pier walls.

The Cockfield dyke, which for its great length is the most noted in this district, occurs in the south of Durham. Proceeding out of Teesdale it is first recognised on the Cockfield moor, where it intersects the southern edge of the coal basin. It forms a large boss on the hills near Bolam, where it has extended on each side of its fissure. Though not seen in contact with the Magnesian limestone, the latter is thrown on edge near the line of its course. It is buried beneath the alluvial deposits of the south-east of Durham till it approaches the banks of the Tees, when it again appears cutting through the New Red Sandstone. It crosses the Tees at Preston, and is extensively quarried at Barwick on the opposite side and in a few other places until it reaches the escarpment of the Cleveland hills. It has been traced across the Cleveland hills to within a few miles of Scarbro'.

DEVONIAN.

" In Northumberland we find it in Roddam Dene, on the flanks of the Cheviot porphyry, where it contains rolled pebbles, and blocks of this porphyry, showing that the Cheviots had been protruded previously to the deposition of the Old Red Conglomerate. In Berwickshire, where this formation occupies a considerable area, there is no physical break between the Old Red Sandstone and the Carboniferous formation; but the limits of the former are nearly marked by the occurrence of *Holoptychius nobilissimus* and *Pterichthys major*, which are characteristic of the upper beds of the Old Red Sandstone."—*Tate.*

SILURIAN.

" Small portions of this formation occur in the westernmost part of Northumberland, where it is seen on the flanks of the porphyry of the Cheviots, on the Coquet, above Philip, and again in a similar position at Whitelee on the Reed, near to Carter Fell."

PORPHYRY OF THE CHEVIOT.

" A considerable tract of the north-west of Northumberland is occupied by the Cheviot hills, which rise from below the stratified formations above-mentioned. As the higher portions of these hills are covered with peat and moss, and their slopes with alluvial soil, it is not easy to trace the exact line of separation between the porhyritic rocks of which they consist and the previous groups. The blocks of stone on the summit of Cheviot consist of flesh-coloured felspar, porphyry enclosing reddish-white felspar, and occasionally minute crystals of hornblende. Among the blocks which lie scattered by the side of the Wooler waters, porphyry slate, claystone porphyry, porphyritic syenite, and coarse red jasper may be recognized; and the Coquet, Aln, Breamish, and Glen abound with agates."—*Winch.*

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